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Mass Casualties in Combat: Lessons Learned

MAJ Alec C. Beekley, MD, FACS

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The generation of *multiple* casualty events, where the number of casualties do not overwhelm medical resources, is the norm in modern warfare, and the current military trauma systems in Iraq and Afghanistan routinely and effectively deal with these events. *Mass* casualty events, where the number of casualties overwhelms the local medical resources, are less common events but still occur with greater frequency during military conflicts than in civilian settings. Recent terrorist attacks in civilian settings, such as the attacks on the World Trade Center on September 11, 2001, and the Madrid and London train bombings, have blurred the traditional lines between civilian and military trauma by generating large number of casualties at once with injuries from explosives. Hence, the experiences and lessons learned by military surgeons in modern conflicts with regard to mass casualty events undoubtedly resonate strongly with our civilian colleagues and must continue to be shared.

The military trauma system in Iraq has evolved from one based largely on small, mobile, forward surgical (echelon IIb) units during the maneuver phase of the war to a robust, well-planned system based primarily on larger fixed facilities (e.g. combat support hospitals, echelon III).[1] Forward surgical units currently augment the echelon III facilities or provide task-oriented surgical support in areas of high operation tempo. This allows for the evacuation of the majority of casualties directly from point of wounding to a facility where maximal surgical, medical, and blood bank support can be leveraged and damage control surgical techniques combined with damage control resuscitation can be brought to bear.[2]

Critical to the successful management of multiple and mass casualties is the process of triage. The Emergency War Surgery Manual provides important guidelines for this process, emphasizing that triage must occur at multiple levels of care and be repeated until all casualties are treated.[3] Experiences in Iraq provide several lessons learned regarding triage, as follows: 1. proximity of hospital to mass casualty event can complicate triage; 2. performance of triage is effected by casualties' modes of arrival, the physical layout of the medical treatment facility, and the presence of incoming hostile fire (among other factors); 3. triage and re-triage should occur at or near the point of wounding, on the helipad at receiving facilities, at the trauma bay door, in the trauma bays, and in the operating room; 4. radial pulse character and Glasgow Coma Scale Motor score can provide fast and reliable triage criteria for distinguishing between stable and unstable patients[4]; 5. initial triage at echelon III facilities should be performed by senior/experienced surgical personnel who are not directly involved in patient care; 6. providers assigned to specific patients should stay with those patients unless reassigned by triage officer; 7. Focused Abdominal Sonography for Trauma (FAST) and CT scan (where available) can be effective triage tools to prioritize patients[5–7]; and 8. surgeons must be willing to re-triage patients in the operating room as expectant based on injuries identified, blood products required, physiologic status of patient, and number of other casualties requiring operation.

The ability to predict resource needs based on the number of casualties generated by a mass casualty event was described by Soffer et al. in their analysis of blood product utilization after terrorist attacks in Israeli.[8] These researchers created a novel predictive index, the packed cells per patient index (PPI), and found that the average PPI for 19 consecutive terrorist attacks was 1.0. 5.7% of their casualties required massive transfusion (>10 units of blood). A similar analysis was applied to the management of 50 multiple or mass casualty events by a single combat support hospital (CSH) in Iraq. The number of casualties treated during these events was (at least) greater than one SD over the mean number of casualties treated per day at the CSH. The average number of patients for these 50 days was 24. 1327 units of blood were transfused on these days for an average of 26.5 units per day. On average, 20% of casualties required transfusion and 5% required massive transfusion. These percentages remained consistent regardless of number of casualties per event or predominance of blast or gunshot wounds as wounding mechanism, with the exception that when the mass casualty event was caused by a single explosion, the percentage of patients requiring massive transfusion doubled (9.6%). The average PPI for these days was 1.12. These numbers are strikingly similar to Soffer's findings. Days where the PPI greatly exceeded the average were rare, and analysis of these events revealed cases where casualties were over- or under-triaged with resultant expenditure of large amounts of blood products

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US Army Medical Corps, Madigan Army Medical Center, Tacoma, WA; email: alec.beekley@ amedd.army.mil.

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on casualties who were likely unsalvageable. Finally, there was no correlation between the number of casualties per event and mortality.

In summary, the current military trauma systems in Iraq and Afghanistan are effective at dealing with both routine multiple casualty events and the less common mass casualty event. Analysis of multiple and mass casualty events from current conflicts can provide critical lessons learned regarding triage and resource utilization which can potentially be applied to other conflicts or civilian multiple or mass casualty events. Although the findings of this study regarding blood product utilization may not be directly applicable to catastrophic, national-level events, the consistency of the findings with the Israeli experience and across a wide range of smaller multiple or mass casualty explosion-related events is striking. Hence, for such events, the number of casualties generated may provide a reliable *baseline* prediction of blood product needs and percentages of patients who will require transfusion and massive transfusion. This in turn can help determine distribution of casualties among medical treatment facilities and allow for activation of additional blood resources, such as notification of more distant blood banks or initiation of fresh whole blood drives. Clearly, the experiences with mass casualty events that both military and civilian surgeons encounter must continue to be studied and shared.

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